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METEOROLOGICAL ASPECTS OF ENERGY PROBLEMS

(Submitted by the Secretary-General
of the World Meteorological Organization)

NOTE

Further to the contents of the basic document (E/CN.14/NRSTD/E/14), the present paper reviews in particular the decisions taken by the twenty-eighth session of the WMO Executive Committee (Geneva, June 1976) regarding a WMO plan of action in the field of energy problems as well as the relevant conclusions of the UNESCO/WMO Solar Energy Symposium (Geneva, 30 August - 3 September 1976).

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Introduction

1. A WMO plan of action in the field of energy problems was approved by the twenty-eighth session of the WMO Executive Committee held at Geneva in June 1976. This plan called for the implementation of a wide range of activities in the application of meteorology to the utilization of wind and solar energy and other new sources of energy as well as to ways and means of securing more efficient uses of energy derived from conventional sources.

2. For the purpose of promoting the application of meteorological data and knowledge more specifically to the utilization of solar radiation in solar energy technology, UNESCO and WMO organized a joint Solar Energy Symposium in Geneva in August 1976.

Purpose of the present document

3. The purpose of this document is to report on the new WMO plan of action in the field of energy problems and on the relevant conclusions of the UNESCO/WMO Solar Energy Symposium in view of the involvement of African meteorological services in the implementation of the plan of action and of the conclusions of the Symposium.

WMO plan of action in the field of energy problems

4. At its twenty-eighth session, the Executive Committee of WMO emphasized that, with a view to meeting the requirements of technologists dealing with wind and solar energy utilization, efforts should be made urgently to provide them with suitable meteorological information for the assessment of the quantities of energy obtainable from wind and solar radiation in different geographical areas. It was further stressed that meteorology would be able to make a very important contribution to harnessing wind and solar energy by providing the analyses needed to indicate to what extent in various climatic zones wind and solar radiation could be used for the production of energy. Attention was also drawn to the need to transfer to developing countries, as a matter of urgency, available knowledge in the field of the application of meteorology to the use of new energy sources as well as to ways and means of securing more efficient uses of energy derived from conventional sources.

5. By its resolution 15(EC-XXVIII), members of WMO were invited:

"(1) To improve the possibilities of obtaining, for application to energy problems, reliable relevant meteorological information, in particular wind and solar radiation data, from meteorological stations and to extend, as appropriate, the networks of such stations especially to meet the needs in rural areas;

...

(6) To draw the attention of appropriate authorities and experts to the use and application of meteorological and climatological information to the development of non-conventional energy resources, in particular those related to wind and solar radiation."

6. In the WMO plan of action in the field of energy problems, high priority has been allocated to the following items:

A. Energy production, wind and solar radiation energy

7. Preparation of technical note(s) on meteorological aspects of the use of solar energy;

8. (a) Arrangement of a joint meeting between solar radiation specialists within WMO on the one hand and solar energy technologists on the other hand in order to consider the factors relating to solar radiation and other meteorological information in their application to solar energy utilization;

(b) Arrangement of a joint meeting between wind specialists within WMO on the one hand and wind energy technologists on the other hand in order to consider factors relating to wind and other meteorological data in their application to the utilization of wind energy;

9. Preparation of a review of the present state of knowledge in the application of meteorology to nuclear plant site selection and operations;

10. Preparation of an information and guideline document or WMO statement on the meteorological aspects of possible local and regional consequences of heat release to the atmosphere;

11. Preparation of a special environmental report to draw the attention of both meteorologists and users to various ways in which meteorology could be used in solving problems in the energy area.

B. Specific research topics to be undertaken by WMO technical commissions

12. (i) Study on estimates of variation of wind with height (Commission for Atmospheric Sciences);

(ii) Study on instrumental problems (Commission for Instruments and Methods of Observations);

(iii) Studies on the way in which solar radiation and sunshine duration data could be most usefully presented to users of solar energy (Commission for Special Applications of Meteorology and Climatology);

(iv) Research on atmospheric radiative transfer and ground albedo and the need to establish solar radiation stations for research purposes (Commission for Atmospheric Sciences).

C. Other New Energy Sources

13. (i) Development of the requirements for the application of meteorology in tidal and wave energy production;

(ii) Bio-conversion in the oceans for energy production;

(iii) Study of the thermal and chemical consequences of ocean thermal energy generating systems; and

(iv) Environmental pollution aspects of the use of geothermal power generating systems.

(The work is to be undertaken by the Commission for Atmospheric Sciences, the Commission for Special Applications of Meteorology and Climatology and the Commission for Marine Meteorology).

14. It may be of interest to mention that, already in 1954, WMO published a Technical Note on Energy from the wind - Assessment of suitable winds and sites, which will be replaced by a new Technical Note as indicated above.

15. The UNESCO/WMO Solar Energy Symposium mentioned above was held at Geneva from 30 August to 3 September 1976. There were 15 African countries among a total of 55 countries represented at the Symposium. The programme referred to: (i) solar radiation as a natural resource; (ii) development of techniques in relation to the conversion of solar energy including education and training; and (iii) planning and the co-ordination of international activities to harness solar energy. In view of their relevance to the Accra discussion, the pertinent conclusions of the symposium are reproduced in the annex to the present document.

16. The proceedings of the symposium, including the complete texts and summaries of papers presented as well as the conclusions arrived at during the symposium, will be published in due course.

WMO regional activities in Africa

17. The WMO Regional Association for Africa established in 1953 a working group on radiation to advise members of the African region on the development of their national networks of radiation stations and to co-ordinate their efforts in this field.

18. Most of the African meteorological services publish locally data from their national radiation networks for different users. In addition, radiation data from 110 stations in 23 African countries are being sent regularly to the Leningrad Centre for inclusion in the WMO-sponsored monthly publication "Solar radiation and radiation balance data (the world network)".

19. In this connexion, it might be mentioned that, beginning in 1954, radiation data in Africa used to be published regionally in the "Quarterly Radiation Bulletin for Africa". However, the WMO Regional Association for Africa decided in 1969 that there was no need to continue the publication of radiation data regionally after the establishment of the publication with world coverage referred to in the previous paragraph.

20. Special attention is being given by the WMO Regional Association for Africa to the need to have standardized radiation measurements in Africa. To this end, the following measures have been taken:

(a) Five regional radiation centres have been established in Africa at: Cairo (Egypt), Khartoum (the Sudan), Kinshasa (Zaire), Tamanrasset (Algeria) and Tunis (Tunisia). These centres have been designated by the Regional Association for Africa to serve as centres for international comparisons of radiation instruments within the region and to maintain the standard instruments necessary for this purpose;

(b) A regional comparison of national standard pyrheliometers in Africa was organized at Sidi Bou Said (Tunisia) from 19 to 30 July 1976.

Concluding remarks

21. Some of the conclusions and actions proposed in the general field of meteorological input to energy development studies were given in the basic document submitted by WMO.

Annex: Conclusions and suggestions of the UNESCO/WMO Solar Energy Symposium

A. Meteorological aspects

General

1. With a view to meeting the requirements of users in the field of solar energy, coordinated efforts should be made to promote radiation climatology towards the specific needs for evaluating solar energy utilization.

2. In the field of solar radiation, there is a need to improve the network of meteorological radiation stations and standardize units, calculation methods of various parameters, statistical methods and the presentation of data. Furthermore, the presentation of radiation data such as those related to the inclined surface should be standardized.

B. Use of available data

3. For applications such as thermal conversion, radiation data should be completed with relevant standard meteorological data - mainly sunshine duration, air temperature, wind speed and direction - and be presented together with them; furthermore, whenever possible, the radiation and meteorological data should be made available on computer compatible means, such as magnetic tape with a standardized format.

4. The network of global radiation measurements seems to be sufficiently dense for general design purposes in northern middle latitudes, but it should be improved in other geographical areas.

5. For design purposes, the accuracy of 5 to 10 per cent of the instruments used in the network seems sufficient. More attention, however, should be paid to quality control and calibrations procedures in order to ensure this accuracy out in the field.

6. In view of the requirements, arrangements should be made to increase the number of stations measuring diffuse and/or direct radiation within national radiation networks. For the design of solar houses, only values of global and diffuse radiation are needed (actual and monthly values).

7. For the evaluation of spatially interpolated mean values (for periods longer than 10 days) of the radiation on a horizontal surface, existing calculation schemes can be used yielding sufficiently accurate results.

8. The existing calculation schemes for the assessment of radiation (both global and diffuse) data on inclined surfaces based on horizontal surface measurements, still need to be improved. A more detailed knowledge of the distribution of diffuse radiation over the sky for clear and cloudy conditions is needed for this purpose. Such experimental studies should be carried out at specially selected stations to improve modelling methods.

9. More attention should be devoted to the frequency distribution of insolation in relation to the time variability of cloudiness. This information could be obtained from surface observations and from satellites. A special evaluation technique should be developed to use the available radiation and cloud information from satellites. The shortest time interval to be taken into account is of the order of a few minutes.

C. Special measurements requirements

10. In view of the increasing use of photovoltaic cells, of photosynthetic and biological systems, the need was expressed to have more detailed information on spectral solar and sky radiation. However, because of limitations in terms of accuracy, it was agreed that such measurements should be made only at special research stations and that interpolation procedures should be developed for points between the stations and time intervals between different weather situations. Further spectral transmission functions from geostationary satellites should be incorporated in the interpolation scheme.

11. Methods for the calculation of various radiation parameters, in particular such as turbidity, should be standardized. Further methods should be developed to establish turbidity climatology.

D. Availability of published data

12. In addition to the present programme carried out by the World Radiation Centre at Leningrad, the following activities could be proposed to the same centre:

(a) Inventory of existing data on horizontal surface should be improved and completed by information related to inclined surfaces;

(b) Preparation of a monograph on existing information about radiation conditions in the world in connexion with specific purposes of solar energy utilization.

E. Efficiency determination

13. The requirements of and the use of meteorology data for efficiency determination of solar energy converters should be standardized in detail. In view of the difficulties in determining relevant parameters, meteorologists, in collaboration with solar energy engineers, should elaborate recommendations on the methods to be used.

14. The now available silicon detectors for irradiance measurements should be tested for their use as an inexpensive replavement for conventional instruments.